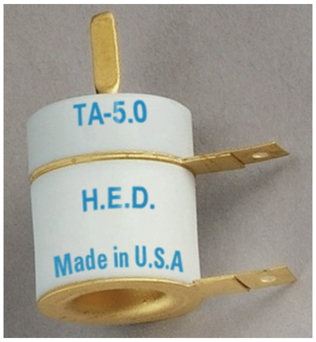
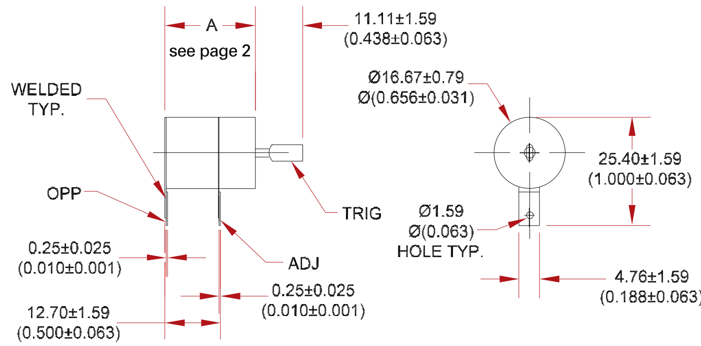
TA Series Triggered Gaps for Military and Aerospace
Application Note





Introduction

The TA Series of ceramic-to-metal triggered spark gaps has been designed to fill the need for low and medium voltage, medium energy and small size applications, which exist throughout the military and industrial complex. These gaps, available with main static breakdown voltages of 1kV through 15kV, permit an expanded choice by the design engineer to accommodate advanced circuit designs beyond the constrained operating voltage of some existing components such as the GL-7964.

In addition to being small and extremely rugged, these units have excellent time delay, low jitter characteristics, long life relative to their size, and a good resistance to nuclear radiation. The gaps are also capable of high levels of current conduction. The electrodes consist of pure Molybdenum in a dome shaped configuration for high reliable applications in which holdoff voltages as high as 80% of the main static breakdown may be maintained for extended periods without occurrence of premature breakdown. Flexible manufacturing methods at High Energy Devices permit the product for each application to be optimized for breakdown voltage selection as well as required breakdown tolerance.

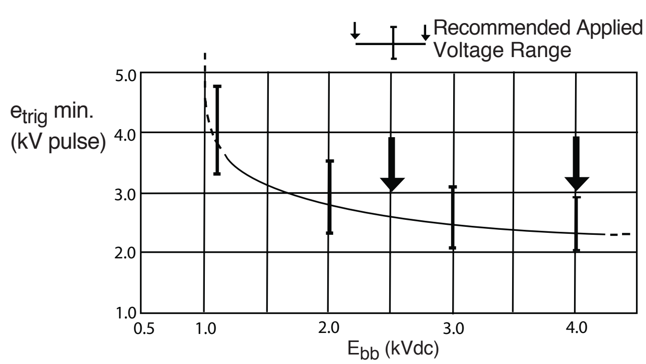
The mechanical features of the TA Series include a tight main static breakdown with a standard voltage tolerance of ± 10%, rugged ceramic-metal construction, refractory metal electrodes with gold plated exterior contacts for easy soldering of contact leads. The design allows the gaps to withstand high shock and vibration level and reliable operation over a temperature range from -55ºC to +125ºC. The minimum interelectrode resistance is 1000 Megohms. The gaps are insensitive to mounting position.

General Ratings

Temperature Range:	-55ºC to +125ºC
Insulation Resistance:	1000 MΩ min.
Shock:	750 g @ 1 sec duration
Vibration:	30 g to 2,000 cps
Mounting:	may be mounted in any plane

Radiation levels necessary to cause more than 10% reduction in main static breakdown:

1. Continuous gamma radiation, 5×10^5 R/hr, for gamma energies of 0.5 MeV maximum.
2. Pulsed gamma radiation, 2×10^7 R/hr, in a 20μsec burst for gamma energies of 1.0 MeV maximum.
3. Neutron dose rate, 10^{13} to 10^{14} neutrons/cm^2 sec.
4. Neutron total dose, 10^{10} neutrons/cm^2



Typical curve of e_{trig} min. (minimum trigger voltage) vs. E_{bb} (applied voltage on main electrodes) for a TA5.0 in Mode A with trigger pulse per Note 2.

Table of Characteristics

Part #	Applied Voltage Range E_{bb} (kVdc) (1)	Main Static Break-down E_Z (kVdc) (1)	Minimum Trigger Voltage E_{trig} min (kV Pulse) (2)	Energy (Joules) (3)	Charge Transfer Q Coulombs (4)	Peak Current (ka) (5)	Delay Time (μs) (6)	"A" Dimension (Inches)	Max. Weight (Grams/ Oz)
TA1.0	0.50-0.80	1.0	3.0-2.5	45	110	10	0.05	0.75	13.5 / .47
TA2.0	1.0-1.6	2.0	3.0-2.5	50	62	10	0.08	0.76	14.0 / .49
TA2.5	1.25-2.0	2.5	3.3-2.5	50	62	10	0.08	0.76	14.0 / .49
TA5.0	2.5-4.0	5.0	3.3-2.5	50	25	10	0.08	0.76	14.0 / .49
TA7.5	3.75-6.0	7.5	4.0-3.0	50	18	10	0.10	0.79	14.0 / .49
TA10.0	5.0-8.0	10.0	5.0-3.5	60	12	10	0.12	0.79	14.5 / .51
TA12.5	6.25-10.0	12.5	6.5-3.5	60	12	10	0.12	0.83	14.5 / .51
TA15.0	7.5-12.0	15.0	8.0-4.5	75	11	10	0.15	0.83	15.5 / .55

Notes:

(1) The applied voltage range includes the recommended minimum and maximum voltages which can be applied to the gap and insure operation every time, at the low end, plus that voltage above which self-firing might be avoided at the end of life, at the high end. This range is typically 50-80% of the main static breakdown.

(2) Minimum trigger values are given for Mode A operation for the indicated applied voltage levels. The trigger pulse has rise time and pulse width values as follows: t_r = .5μs (10-90%) and t_p = 3.0μs (50%). For high reliability circuits and for applications, which require reduced delay times, e_{trig} should be at least 150% of E_{trig} min.

(3) The energy ratings are for at least 1000 firings with a load of 0.2 ohm in series with the gap and with an end point of a 20% reduction in E_Z.

(4) The lifetime of the triggered gap can be approximated in terms of the cumulative charge, in coulombs (Q), that can be passed through the device without changing its Main Static Breakdown Voltage by more then 20%. Expressing the height of the current pulse in amperes and the duration in seconds, the area under the pulse is the coulomb of charge contained in it.

Example: A 10kV triggered gap must dump a 2.0μF capacitor charged to 8.0kV. The charge stored in the capacitor is:
$q = CV = 2.0 \times 10^{-6}$ farads x 8000 Volts
$q = 0.016$ coulombs

If the Coulomb Rating (Q) is given as 100 coulombs, the life under these conditions is approximately:
Life = Q/q = 100/0.016 = 6250 discharges

(5) The peak current is given as a conservative maximum current pulse, which is approximately triangular or half sinusoid of 30μs half-width.

(6) Delay times are measured from 10% of trigger discharge current amplitude to 10% of main gap discharge current amplitude. Typical trigger pulse is described in Note 2. Listed delay times are E_{bb} = 50% E_Z in Modes A & C operation. Delay times are longer for negative trigger pulses.

Definitions

E_Z: Main Static Breakdown voltage between Adjacent and Opposite Electrodes.

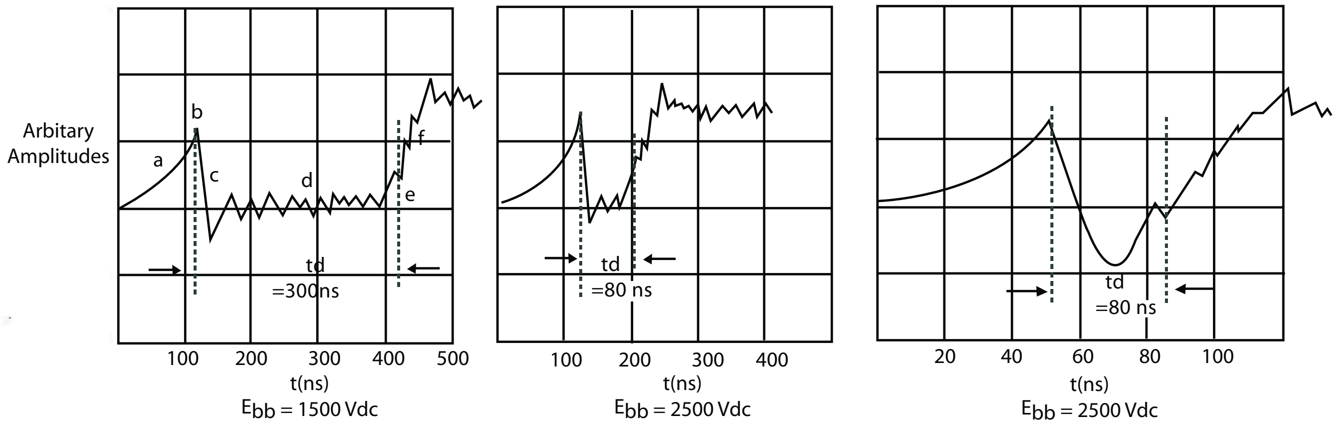
E_{bb}: Applied DC voltage between the Adjacent and Opposite Electrodes.

E_{trig} min: The minimum pulse voltage applied between the Trigger and Adjacent Electrodes operating in Mode A to result in main gap breakdown.

Time Delay: The time required for the main discharge to occur after the application of the trigger pulse. Specifically, the time is measured from 10% of the leading edge of the trigger pulse to 10% of the leading edge of the main gap current flow.

Jitter: The variation in delay time from shot to shot.

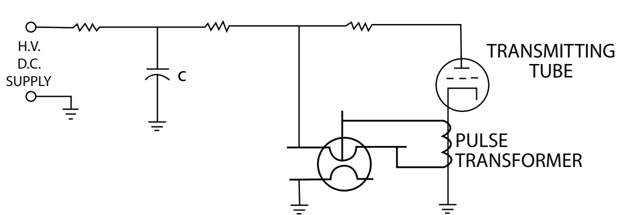
Delay time* vs. Applied Voltage for a typical TA5.0



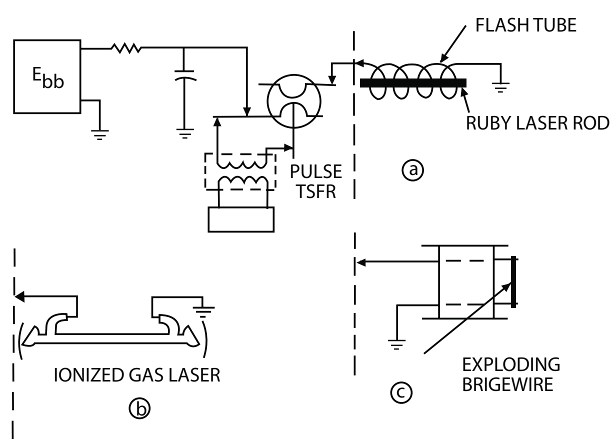
*The actual scope pictures, illustrated as drawings above, resulted from the use of two probes with differing attenuation ratios, both joined into the same scope input. The first probe was across the secondary of the trigger pulse transformer and the second was across a resistor between the gap and ground. Both the trigger current and the main gap current flowed through this resistor. In the picture on the left, the various labeled segments of the trace resulted from the following sequence of events:

a: Trigger voltage rising
b: Trigger breakdown
c: Trigger current build-up and trigger voltage fall-off (cross-over region for the two probes outputs)
d: Quasi static condition of trigger current flowing
e: Main gap breakdown
f: Main gap current rising

Applications



Typical Electronic Crowbar Application



Active Switching Applications

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